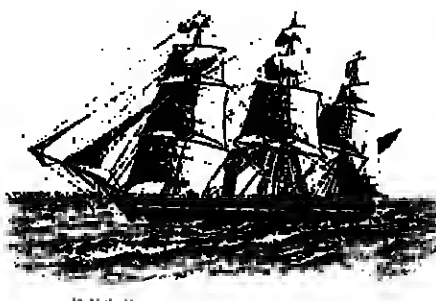






# The Oceanography Report



U.S. Navy ship USSC-19, prepared for the 1982 RSE.

## The Oceanography Report

The report is a compilation of physical, chemical, geological, and biological oceanography.

Editor: Arnold L. Gordon, Lamont-Doherty Geological Observatory, Palisades, NY 10964 (telephone 914-353-2200, ext. 325).

## NRL Remote Sensing Experiment

G. R. Valenzuela, D. T. Chen, W. D. Garrett, and J. A. C. Kaiser

### Background

Sensat synthetic aperture radar (SAR) images of the ocean contain a wealth of ocean features ranging in size from 100 km mesoscale eddies to internal waves and decimeter surface waves (Brace et al., 1981). In particular SAR and SLAR (side-looking airborne, or real-aperture, radar) imaging of shallow water (usually less than 10 m deep) near coastal areas (e.g., Nantucket Shoals, English Channel, German Bight, etc.) contain features that relate almost one to one with the bottom topography (see cover figure as an example). Also evident in the cover figure are tide-induced internal waves (top and middle right in the image), a number of current rips, a current shear front near the bottom edge of the image, and the dark region covering a great part of the middle portion indicating small microwave backscatter power, the result of very stable atmospheric conditions owing to cold upwelling water underneath warm air.

It is well known that stable atmospheric conditions reduce the amplitudes of the surface waves (Valenzuela, 1983), in particular the short gravity (Briggs resonant) waves which are the main contributors to the microwave backscatter power (Wright, 1978). We emphasize that the phase distortion introduced by the motion of the Briggs resonant waves also contributes to the SAR image intensity (Valenzuela, 1980; Alpers et al., 1981; Plant and Keller, 1983).

The topographic related features in the SAR image cannot be the result of direct probing of the sea bottom by the electromagnetic radiation; microwave fields decay by about two thirds while penetrating only a few centimeters into sea water (about 1 cm at 1.275 GHz, the frequency of Seasat SAR), while the water depth at the imaged features is generally of the order of meters to tens of meters. Hence these patterns in radar imagery clearly must be the result of hydrodynamic

ic processes that are coupled to the bottom topography and, at the same time, modulate the amplitudes of the surface ocean waves to a length comparable to the radar wavelength (30 to 40 cm waves for Seasat SAR); such surface waves are the main contributors to the microwave backscatter power received by the radar sensors.

To address this question involving the coupling of the bottom topography with the surface waves, scientists at the Naval Research Laboratory (NRL) proposed in 1980 a comprehensive remote sensing experiment denoted as SEBEX (Surface Expression of Bathymetry Experiment) (Valenzuela and Chen, 1983). Targeted for the vicinity of Davis Bank, Nantucket Shoals (Figure 1) SEBEX involved coordinated remote and in situ measurements to delineate the processes responsible for the features in radar imagery. Initially, a number of academic, governmental, and industrial institutions were to participate in SEBEX, but it eventually evolved into an almost all-Navy program. The present NRL Remote Sensing Program (RSP) on wave-current interactions is based on the original objectives of SEBEX. RSP is funded mostly with NRL in-house research and is also supported by the Coastal Sciences Program of the Office of Naval Research (ONR).

### Program Scientific Objectives

RSP aims at the development, testing, and validation of appropriate hydrodynamic and electromagnetic scattering models; the models would describe the physical processes responsible for the formation of radar imagery over ocean surface features such as bottom topography in near coastal regions. Theoretical work, controlled wave tank studies, and ocean field experiments will be used. Three remote sensing experiments are contemplated: (1) the pilot exercise performed in July 1982 at Phelps Bank, (2) a more definitive one in the summer of 1984 exploiting the opportunity of a Shuttle Imaging Radar-B shuttle flight, and (3) a concluding experiment in 1986.

The original objectives of SEBEX (included in those of the present RSP) are to delineate and quantify the processes responsible for surface expressions of bathymetry in the wave field, radar, and other imagery of shallow water, considering the effects of: (1) air-sea temperature and difference in atmospheric stability, (2) nonuniform currents, (3) complex bottom topography with current fields and temperature structure, and (4) fronts.

### Description of the Phelps Bank Experiment

During July 6-25, 1982, the NRL Remote Sensing Experiment (RSE), the first of three, was conducted in the vicinity of Phelps Bank, Nantucket Shoals, Mass. (Figure 1) to investigate current frontal/tidal interactions with surface ocean waves and their effects on radar imagery. Air-sea temperature differences (atmospheric stability) and wind vector effects also were of major concern in this pilot experiment. For simplicity the experiment was concentrated over one bathymetric feature of the shoals (i.e., Phelps Bank). The primary purpose of this pilot experiment was to gain experience for the more definitive efforts to follow in 1984 and 1986. We also desired to extract as much pertinent physics as possible with the limited set of measurement resources available. Two auxiliary experiments on ship wake chemistry and physics and Langmuir circulation were also performed

Investigator	Area of work
G. R. Valenzuela (Chief Scientist), NRL	Remote sensing (SAR/SLAR), bathymetry-current wave interaction, and nonlinear dynamics.
D. T. Chen (General Coordinator), NRL	Current-wave interaction, ocean wave spectra, and remote sensing.
W. D. Garrett (Senior Scientist onboard USNS Hayes), NRL	Surface films, thermistors, and physics of water, gelation, and remote sensing.
Jack A. C. Kaiser (Deputy SNOB), NRL	Thrust transfer, micro-layer dynamics, hydrograph, meteorology, and mass transport.
C. M. Gordon and D. Greenwalt, NRL	Eulerian and Lagrangian current, mass transport, marine geology, and turbulence.
W. J. Plant and W. C. Keller, NRL	Remote sensing (ROWS/SAR/SLAR), wave dynamics, and air-sea interaction.
D. L. Schuler, NRL	Remote sensing (ROWS-SAR), surface currents and signal processing.
J. R. McGrath, NRL	Langmuir circulation, ocean currents, and physical oceanography.
S. E. Rienecker, NRL	Physics of waves and hydrodynamics.
P. Smith, NORDA	Infrared remote sensing and physics of waves.
S. A. Placzek, NORDA	Hydrodynamic modeling of circulation.
R. J. Liu, David Taylor Naval Ship R&D Center	Directional wave spectrum, current-wave interaction, and numerical modeling.
R. A. Shuchman and J. D. Lyden (SAR data coordination), Environmental Research Inst. of Michigan	Remote sensing (SAR/SLAR), image processing, and current-wave interaction.
N. D. Smith and J. A. Ewing, Inst. of Oceanographic Sciences, UK	Directional wave spectrum and wave prediction models.

during the July 1982 experiment; however, these will not be discussed here.

The RSE team comprised a dozen NRL scientists lead by G. R. Valenzuela (Chief Scientist), D. T. Chen (General Coordinator), W. D. Garrett (Senior Scientist on Board (SSOB) USNS Hayes) and J. A. C. Kaiser (Deputy SSOB) who also was the principal investigator on the hydrographic survey. The complete list of scientific participation is given in Table 1. The pilot experiment used the USNS Hayes (T-AGOR 16) research ship which performed standard oceanographic and meteorological measurements, including a hydrographic survey of the Phelps Bank area with a Neil-Brown conductivity-temperature-depth (CTD) profiler and wide expendable bathythermograph (XBT) probes. Lagrangian and Eulerian current measurements by drogues and moored current meters, and surface wave measurements by roller-leaf and Endeco buoys were also made.

Meanwhile, coordinated and synchronized remote measurements were performed from the NRLP-3 aircraft with X-Band (9.375 GHz) remote ocean wave spectrometer (ROWS), pulsed laser profilometer, infrared thermal scanner, and optical strip camera. Two U.S. Marine Corps RF-4's also participated with X-Band (APD-11) SAR systems. An L-Band (1.236 GHz) dual mode ROWS-A-R radar was mounted on the Hayes to determine directional wave spectra and near-surface currents. The modulation in energy (amplitude) of the Bragg resonant waves on the ocean surface (12 cm waves at 1.236 GHz and 2.26 cm waves at 9.375 GHz) also may be obtained from the amplitude channels of ROWS systems.

An example of the surface features we are interested in is shown in Figure 2. This is Asia Rip on the southwest side of Phelps Bank, an extreme case which is visible to the naked eye. However, this is an exception; in many other cases the surface features can be observed only with radar, infrared, or other sensitive sensors.

### Preliminary Assessment

The 1982 RSE has provided data on current shear/tidal interactions with the surface ocean waves and with the bottom topography. It also provided synchronized remote sensing observations of the amplitude modulation of the short Bragg resonant waves with X-Band airborne SAR, and L- and X-Band ROWS's. A preliminary assessment indicates that in addition to fulfilling the role of a pilot experiment, enough data was obtained to partially understand the surface effects.

During the experiment at Phelps Bank the ocean wave height ranged from 0.5 m to 1.5 m and the winds were mostly 5 m s<sup>-1</sup> but occasionally reached 10 m s<sup>-1</sup>. The stratification of the air-sea boundary was unusually stable, with the air 5°C to 7°C warmer than water, which partially decoupled the wind from the sea surface. This allowed only small-amplitude, short Bragg resonant waves and hence small backscattered electromagnetic power. All the pertinent environmental information recorded from USNS Hayes has been processed and is being published in NRL reports (see list).

From the measurements a number of important results have already been derived, and investigations continue. Tidal current fields (magnitude and direction) at Phelps Bank are available from Lagrangian drogues and moored current meters at depths of 6 m and 18 m depths (Garrett et al., 1982). Also Eulerian current measurements were performed from one moored drogued buoy at the edge of Phelps Bank (40° 00' N, 69° 19' W) with current meters at 5-m, 15-m, and 21-m depths (Greenwalt et al., 1983). From these measurements data on the local horizontal and vertical variability of the current field have been obtained.

However, the measurements are still not adequate for one to infer the detailed spatial and temporal structure of the circulation in the area; this should be one of the objectives of future efforts. The measurements showed tidal currents as large as 0.78 m s<sup>-1</sup> toward 10° and 190°, and a persistent along-shoal residual of 0.25 m s<sup>-1</sup> toward 220° on the east edge of Phelps Bank. Hence the measurements demonstrate that Phelps Bank and probably other topographic features in the Nantucket Shoals area can affect the local circulation in such a way as to produce surface features relating to bottom topography (Valenzuela et al., 1983a).

Bathymetric contours sorted in 10° x 10° tesserae of an area 37 km by 26 km including Phelps Bank have been derived from the Precision Depth Recorder (PDR) on the Hayes, and data has been sorted into 1° x 1° tesserae within 19 km of Phelps Bank (Gordon & Kaiser, 1983). Phelps Bank is asymmetric in the east-west direction, with a slope of 0.3° on the east side, the depth decreasing from 40 m to about 20 m, while on the west side the slope is about 10° as it deepens again toward 40 m or so (Gordon and Greenwalt, 1982).

The hydrographic survey of the area with 41 CTD casts and 20 XBT profiles has provided detailed temperature, salinity, and density information of the water column of the area (Kaiser, 1983). From these data it is clear the water is well mixed to the north, west, and over Phelps Bank, while the water becomes stratified toward the southeast and southwest. From composite temperature-salinity diagrams, six distinct water masses can be identified, suggesting that complex mixing is occurring in the area due to interaction of several different current sources. Horizontal current gradients near the west side of Phelps Bank as large as 2 x 10<sup>-3</sup> sec<sup>-1</sup> were observed; however, these are preliminary, coarse sampling results that have to be confirmed with higher resolution sampling of the current field in the planned experiments of 1984 and 1986.

Fifteen-minute averages of meteorological parameters such as wind vector, air temperature, water temperature, dew point/relative humidity, etc., were constructed from data continuously recorded on-board the Hayes throughout the experiment. Parameters derived from the meteorological data and sea surface fluxes have also been obtained (Kaiser and Munch, 1983).

Directional wave spectra of the ocean waves (up to 0.5 Hz) were obtained from a tethered, clover-leaf buoy (Smith and Ewing, 1983) and from a free drifting Endeco buoy (R. Liu and R. Bachman, Variations of surface wave around Phelps Bank, unpublished manuscript, 1983). As mentioned earlier the relative amplitude of 12 cm and 2 cm short gravity waves will be inferred from the amplitude channel of the microwave sensors using the Bragg scattering model (Wright, 1978).

Remote sensing data (amplitude and phase) is available from the X-Band ROWS (July 13, 16, and 14 over Phelps Bank and on July 13, 16, and 21 over the current front) and from the L-Band shipboard ROWS (July 11, 12, 14, and 20 over the Bank and July 19 and 21 over the front). X-Band SAR imagery is available for July 11 and 13 over the Bank and a shear current front which extends northwesterly from the Bank. The backscattered microwave power from both ROWS containing unusually large fluctuations (as large as 30 dB at X-Band and 20 dB at L-Band) that correlate

tative and quantitative information on the physical processes responsible for the generation of surface features in the wave field and radar imagery related to oceanic features such as bottom topography in shallow water. We emphasize once more that the 1982 RSE was planned as a pilot experiment to gain experience in preparation for the more complete experiments planned for 1984 and 1986. The experiment in the summer of 1984 will also exploit the opportunity offered by NASA's space-shuttle-borne SIR-B (L-Band SAR) program. However, the preliminary results of the 1982 Phelps Bank experiment have already gone much beyond the original expectations in quality and scope.

### Acknowledgments

This work would not have been possible without the dedication and efforts of a number of scientists and support personnel, and to all of them we are most grateful and indebted. In particular we would like to mention the scientists listed in Table 1; Hans Doerflinger of ONR for partial funding support (RR02-04-02 and RR02-04-08, P.E. 61153N); Bob Lawson of ONR/West for arranging the participation of the U.S. Marine Corps; the detachment of the Marine Corps RF-4's led by John Laurent and Tom Messer; Gary Smith of NRL Operations Office and the crews of the NRLP-3, John W. Arens of USNS Hayes, and Richard Lewis of NRL and Joseph Deaver of Bendix Corp. for maintaining the equipment and taking data on board NRLP-3. In addition we would also like to thank Lew Galt from the Ship Facility Group at NRL, Jack Ostrander who served as navigator on the Hayes, and Peter Altschell of NRL for providing daily weather forecasts during the experiment, and Matthew Klunder and Frank Gorman who assisted in planning and operating the experiment.

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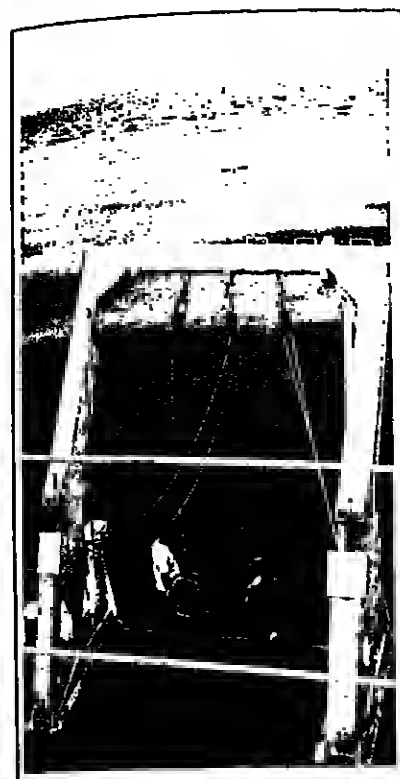


Fig. 2. Visual evidence of surface expression of bathymetry, taken on July 14, 1982, at 14:50 UT at Asia Rip, Phelps Bank, Nantucket Shoals, Mass., during the NRL Remote Sensing Experiment.

with the bottom topographic features [Plant et al., 1983; Schuler et al., 1983].

For a quantitative comparison between the remote sensors and the in situ measurements, appropriate hydrodynamic and electromagnetic scattering models will be required to interpolate/extrapolate the measurements from the 1982 pilot experiment.

Other reports on the RSE include Chen et al. (1982), Denver (1982), Cordon et al. (1983), Gorman and Kaiser (1983), Greenwalt et al. (1983a), Munch and Kaiser (1983), Valenzuela (1983a), Valenzuela et al. (1983a), and J. McGrath, C. M. Gordon, D. Greenwalt, D. McKen, T. Iijima, M. Howard, and M. Carver, Surface manifestation of Langmuir circulation, unpublished manuscript, 1983.

### Summary and Future Activity

The 1982 July RSE appears to be the last fully dedicated effort to yield extensive quality

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Cover: Sensat SAR image of Nantucket Shoals taken on August 27, 1978, at 15:34:14 UT. See the article on the NRL Remote Sensing Experiment in *The Oceanography Report*, this issue.

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DSRV *Alvin* is operated under a memorandum of agreement among the Department of the Navy (Office of Naval Research), the National Oceanic and Atmospheric Administration, and the National Science Foundation. *Alvin* is owned by the Navy and is operated by the Naval Oceanographic Facility at USNOLS, Barbers Point. An *Alvin* review committee in USNOLS examines requests to use the submersible and recommends to the operators at Woods Hole those programs most appropriate for scheduling. "Final selection of projects and establishment of scheduling priorities remain at the discretion of the supporting agencies," Barber said.—ATL

mersible. *Alvin* also was refitted earlier this year so that it can be hoisted by the *Atlantis II* from a single point on the submersible's top. The submersible had been lifted by *Lulu* from below by a crane-like mechanism. *Alvin's* refit cost \$210,000.

*Lulu's* fate is unknown, according to Harrie B. Wallen, manager of submersible engineering and operations at Woods Hole. "Hopefully it will continue to support oceanographic research in some capacity elsewhere," he said.

The *Alvin/Atlantis II* team will work first on research in the western Atlantic and the Caribbean; near December's end the ship and submersible are expected to move into the Pacific. The team probably will be tested in November, according to Jack Donnelly, manager of marine operations at Woods Hole. A tentative schedule for *Alvin* operations has been made for much of 1984; several projects, however, are awaiting funding decisions by various scientific agencies. The autumn 1984 schedule will most likely include research off either San Diego and Central America or the Hawaiian Islands and vicinity. It is anticipated that the *Alvin* will operate in the Pacific in 1985, possibly for a full operating year. This potential extension of Pacific operations beyond earlier plans is possible because the next scheduled overhaul for the submersible should occur no earlier than late 1985 or early 1986.

The first of two workshops to review letters of intent to use *Alvin* for 1985-1987 will be held December 4, prior to the AGU Fall Meeting in San Francisco. The second will be held January 22, 1984, prior to the AGU Ocean Sciences Meeting in New Orleans. Letters of intent should reach the University-National Oceanographic Laboratory System (UNOLS) office 2 weeks before the workshops, according to Captain William D. Harbee, UNOLS executive secretary. Small letters of intent and interest to the Chairman, *Alvin* Review Committee, UNOLS Office, WH-15, School of Oceanography, University of Washington, Seattle, WA 98195 (telephone 206-543-2203).

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## Advisory Council for URI Programs

A 19-member advisory council headed by former Rhode Island Governor Philip W. Noel has been appointed to help chart future research, education, and public service directions for the University of Rhode Island's marine programs.

John A. Knauss, URI vice president for marine programs, said the council's primary purpose is to forge closer ties between private organizations and the university's marine activities, because, he said, much of the research and many of the job opportunities in these activities in the future will likely be tied to industry needs.

The advisory council would have a three-fold purpose: (1) to critique current and projected activities, (2) to help identify future areas of emphasis, and (3) to develop strategies for the involvement of business and industry in the university's marine science activities.

The council is expected to meet twice a year at the Narragansett Bay Campus with agendas focusing on directed discussions and research presentations. It will report its recommendations to the president of the university, in keeping with policies adopted by other campus advisory groups.

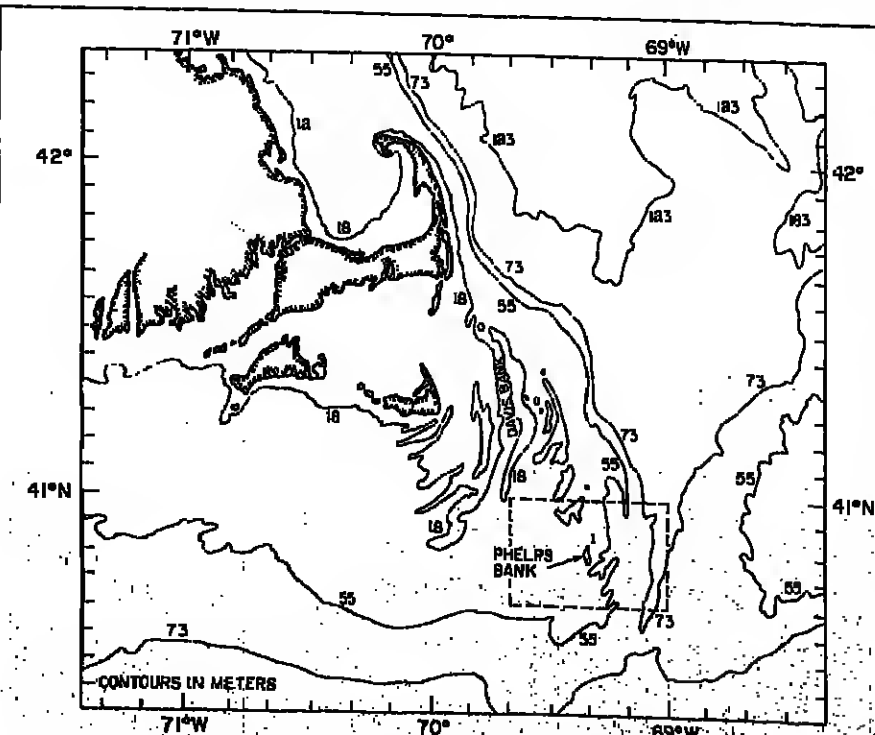


Fig. 1. Complex bathymetry of Nantucket Shoals, Mass., Phelps Bank area (broken lines) where the 1982 NRL Remote Sensing Experiment was conducted.

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Co-Chairmen: P. M. Banks, C. R. Chappell, A. F. Nagy

Co-Convener: C. R. Clauer, J. H. Waite

The 1984 Yosemite Conference will address comparative aspects of planetary plasma environments. Emphasis will be placed on the comparison of plasma sources and energization processes which exist in the inner and outer planets, as well as in comets. The effects of these plasma and energy sources on the composition and dynamics of planetary and cometary magnetospheres will be examined.

All oral presentations will be invited papers. Ample time (50%) will be reserved for discussion. Impromptu presentation of relevant material is encouraged. All contributed papers will be presented during two evening poster sessions. The meeting will be limited to approximately 100 participants.

For more information on abstract submission and meeting registration please contact: C. Robert Clauer, STAR Laboratory, SEL, Stanford University, Stanford, California 94305. Telephone: (415) 497-4691.

Abstract Deadline: December 1, 1983

Pre-Registration Deadline: January 10, 1984

**Faculty Position/Arizona State University Department of Geology.** Applications are invited for an anticipated tenure-track faculty position at the assistant professor level, beginning in August of 1984. The selected candidate will be expected to display excellence in teaching and to develop a vigorous program of research in important geological problems. Possible research areas which would complement or extend existing strengths in the department include solid earth geophysics, sedimentology, and mineral physics.

Please send a detailed statement of research and teaching interests and a resume with names of four references by January 15, 1984 to Paul Smith, Chairman, Department of Geology, Arizona State University, Tempe, AZ 85287. Arizona State University is an equal opportunity/affirmative action employer.

**University of North Dakota/Research Faculty Position.** The Center for Aerospace Sciences at the University of North Dakota has an immediate opening for a research faculty position. The successful applicant will take an active role in measurement programs with research aircraft as well as analysis of the data in conjunction with ongoing research contracts at UND. The position requires a M.S. or Ph.D. preferred in Atmospheric Sciences with a strong background in Cloud Physics. Experience in computer programming and aircraft measurements is highly desirable.

The Center for Aerospace Sciences is experiencing rapid growth and is actively involved in atmospheric research. Research facilities include a 5 cm digital radar unit, automatic rawinsonde equipment, a dedicated computer facility, a Gyroscopic II turboprop, a Citation II jet, and other support equipment.

Salary is commensurate with experience, qualifications, and rank. This is a non-tenure track position at the Assistant/Associate level dependent upon applicant and availability of funds. Position is for 12 months (renewable annually effective July 1).

Qualified applicants are encouraged to send resume to Dr. C.A. Grainger, Center for Aerospace Sciences, ND 58202 University Station, Grand Forks, ND 58202.

The University of North Dakota offers an attractive benefits package, retirement plan, and excellent working conditions. The University of North Dakota is an equal opportunity employer.

**Slidway Institute of Oceanography/Oceanographers.** Several Technical research positions are open for a M.S. in physical or chemical oceanography. The successful candidate will assist in the collection and analysis of hydrographic data from a variety of regions. The candidates must have experience in one or more of the following: oceanographic data collection techniques, nutrient analysis, data reduction and analysis, and programming systems and/or FORTRAN. A demonstrated ability in scientific writing is required of all candidates. Salary is negotiable depending on experience. Please send resume including brief description of professional experience and the names of three references to:

Dr. Larry P. Kishner  
 Slidway Institute of Oceanography  
 P.O. Box 12047  
 Savannah, Georgia 31410.

**North Dakota State Water Commission/Geoscientist.** To work in studies evaluation and management. Bachelor's degree with two years experience or masters degree with experience in quantitative techniques required. Background in watershed modeling, soil physics or watershed flow processes desired. Salary range \$13,555-\$22,774 per month. Send resume to:

North Dakota State Water Commission  
 Building 1000  
 500 East Boulevard  
 Bismarck, North Dakota 58505

North Dakota State University is an equal opportunity/affirmative action employer.

# HANFORD

## Hanford Operations in Washington

Rockwell International has several excellent opportunities at the Hanford Reservation in Richland, Washington:

### Geophysicist

You'll plan, oversee and interpret geophysical exploration investigations in support of the Basalt Waste Isolation Project. Minimum 7 years experience and broad experience integrating various geophysical and geological data is required.

### Mineralogist-Petrologist

You'll plan, oversee and interpret investigations of secondary mineral occurrences in basalt and sediments in support of the Basalt Waste Isolation Project. Advanced degree and minimum 3 years experience in clay or zeolite mineralogy required.

An outstanding compensation and benefits package, including relocation assistance, complements an appealing location. For consideration, please send your resume to:

B.E. White (B15-EOS), Hanford Operations, Rockwell International, P.O. Box 800, Richland, WA 98352. Equal Opportunity Employer M/F. U.S. Citizenship Required.



## Rockwell International

...where science gets down to business

**Instructor/Assistant Professor in Meteorology** January 15, 1984—State University of New York College at Albany. The Department of Earth and Atmospheric Sciences has an opening for a junior or senior faculty member in meteorology. The successful candidate will be expected to teach meteorology and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Meteorology or a related field. The successful candidate will be expected to teach meteorology and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Meteorology or a related field.

A letter of application, resume, and 3 letters of reference should be sent to: Office of Faculty and Staff Relations, 100 State University Plaza, Albany, New York 12242. The deadline for applications is November 10, 1983.

State University of New York College at Albany is an Equal Opportunity/Affirmative Action Employer.

**The University of Texas at Dallas/Sedimentary Geologist.** The Geosciences Program at the University of Texas at Dallas is seeking two dynamic individuals for two tenure-track positions in the general field of sedimentary geology. The successful candidates will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Sedimentary Geology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Sedimentary Geology or a related field.

Applicants should send resume and list of references to: Dr. William F. Doherty, Chairman, Department of Geology, University of Texas at Dallas, P.O. Box 7501, Dallas, Texas 75275.

The University of Texas at Dallas is an equal opportunity/affirmative action employer.

**Structural Geology/Geologist, University of Missouri.** The Department of Geological Sciences at the University of Missouri is seeking a dynamic individual for a tenure-track position in the general field of structural geology. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Structural Geology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Structural Geology or a related field.

Applicants should send resume and list of references to: Dr. William F. Doherty, Chairman, Department of Geology, University of Missouri, Columbia, Missouri 65211.

The University of Missouri is an equal opportunity/affirmative action employer.

**Louisiana State University/Structural Geology (Assistant or Associate Professor).** The Department of Geology is expanding its structural geology program and is seeking a dynamic individual for a tenure-track position. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Structural Geology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Structural Geology or a related field.

Applicants should send resume and list of references to: Dr. William F. Doherty, Chairman, Department of Geology, Louisiana State University, Baton Rouge, Louisiana 70803-4101.

The University of Louisiana is an equal opportunity/affirmative action employer.

**Louisiana State University/Geology (Assistant or Associate Professor).** The Department of Geology is expanding its geology program and is seeking a dynamic individual for a tenure-track position. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Geology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Geology or a related field.

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Applicants should send resume and list of references to: Dr. William F. Doherty, Chairman, Department of Geology, Louisiana State University, Baton Rouge, Louisiana 70803-4101.

The University of Louisiana is an equal opportunity/affirmative action employer.

## USDA Agricultural Research Service, Watershed Erosion Research Unit, Tucson, Arizona

...is seeking a Hydrologist or Research Hydraulic Engineer to conduct research in hydrology, erosion and sediment yield, and water quality in land resource areas of the southwest. Permanent Federal position. Must be US citizen. Salary range \$24,508-\$48,553 (commensurate with experience). Interested applicants should contact Dr. Kenneth Renard at 602/629-6037 for additional information and application procedures.

USDA is an Equal Opportunity/Affirmative Action Employer.

**Geochronologist/University.** Invites applications for a tenure track position in geology. The position is open to individuals with a Ph.D. in Geology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Geology or a related field.

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The University of Texas at Dallas is an equal opportunity/affirmative action employer.

**Staff Scientist/Systems Analyst.** Research and Data Systems, Inc. has openings available for Staff Scientists, Systems Analysts and Programmers/Analysts to work in areas involved in the processing and application of data from satellite based remote sensing systems. Particular needs involve the analysis and processing of Earth Radiation Budget, Micro-wave, AVHRR and LANDSAT data. Needs also exist in the areas of interactive image graphics, software engineering, real time processing and satellite data communication. Successful candidates will have an advanced degree in meteorology, physics, engineering, mathematics, or computer sciences. Hardware background should include IBM, DEC, CYBER or VAX-11/400 equipment. Send resume in confidence to:

Research and Data Systems, Inc.  
 10301 Greenleaf Road, Suite 200  
 Landover, Maryland 20785  
 Telephone: (301) 396-6100

The State University of New York at Binghamton/Petrologist. The State University of New York at Binghamton is seeking a dynamic individual for a tenure-track position in the general field of petrology. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Petrology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Petrology or a related field.

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**Chairman, Department of Oceanography/Old Dominion University.** Due to an internal promotion of the former Chair, the Department of Oceanography is seeking a new Chair. Applications are invited from persons with a Ph.D. in Oceanography or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Oceanography or a related field.

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**The University of Texas at Dallas/Sedimentary Geologist.** The Geosciences Program at the University of Texas at Dallas is seeking two dynamic individuals for two tenure-track positions in the general field of sedimentary geology. The successful candidates will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Sedimentary Geology or a related field. The successful candidate will be expected to teach and to develop a vigorous research program. The position is open to individuals with a Ph.D. in Sedimentary Geology or a related field.

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**The University of Texas at Dallas/Sedimentary Geologist.** The Geosciences Program at the University of Texas at Dallas is seeking two dynamic individuals for two tenure



## Meetings (cont. from p. 621)

## Announcements

## Hydrology at AGU Fall Meeting

## Modeling Aquifer Management

As part of a symposium on Optimization Techniques for Managing Groundwater and Stream-Aquifer Systems, there will be a panel discussion entitled "The Role of Simulation-Optimization Modeling in Aquifer Management." The symposium will be held on Thursday, December 8, 8:30-11:30 A.M., and the panel discussion will run from 11:30 A.M. to 12:15 P.M. The chairman of the session will be Manouche Heitlari, Kansas Geological Survey.

Discussion will focus on issues such as: Can groundwater resources be efficiently managed? Are simulation-optimization models useful in the management of physically, economically, and legally complex aquifer systems? How can management modeling results be implemented? What elements of real systems have not been incorporated in these models? What should be the future direction of management modeling research? The panel members will be John D. Bredehoeft, Nathan Burras, Yacov Y. Hinnies, Thomas Maitland III, Gerald T. O'Mara, and Robert Willis.

## Flood Risk and Streamflow

As a result of AGU's surface runoff committee's activities, several sessions at the 1983 AGU Fall Meeting will focus upon flood risk assessment, using statistical techniques and physically-based models, and also multivariate stochastic streamflow models. Of special importance are the two special sessions on Friday addressing recent flood-frequency research. The morning session on Statistical Procedures for Estimation of Flood Risk at Gage Sites, was organized by J. Stedinger. It contains papers by K. Lettenmaier, D. Hershfield, D. Wall, G. Martin, D. Lettenmaier, D. Newnam, and J. Herrin. W. Thomas, and L. Beard.

On Friday afternoon, a special session organized by J. Valdes will address Searching for More Physically-Based Extreme Value Distributions. Papers will be presented by P. Todorovic, V. Gupta, M. Kavvas, R. Bras, and C. Haktanir. In addition, another 10 papers presenting flood-frequency research will be presented in a general hydrology session on Wednesday afternoon after the hydrology session luncheon. Topics to be discussed in the three sessions include flood measurement error, regionalization procedures, empirical Bayes analysis, WRC's Bulletin 17, use of historical flood information, scale and similarity, and derived distributions for ungaged catchments. The Friday sessions will close with a review by J. Schaake, V. Klemes, and M. Moss, of recent accomplishments and research needs. Individuals interested in flood frequency analysis shouldn't miss this unique event.

Another special session will be on Thursday on Multivariate Modeling of Hydrology and Other Geophysical Time Series, organized by J. Salas. D. Brillinger will give a keynote address. D. Valencia, J. Stedinger, V. Yevjevich, S. Camacho, I. Macneil, W. Laue, R. Hirsch, and D. Woolhiser, will present invited papers in the morning. Other papers will be given in the afternoon meeting and in the general hydrology session on Wednesday. The Thursday afternoon meeting will close with a discussion led by a panel consisting of M. Fiering, S. Burgess, A. Robinson, and D. Sheer.

## Groundwater Instrumentation

The National Water Well Association (NWAW) will hold the Second National Symposium and Exposition on Groundwater Instrumentation in Las Vegas, Nev., April 2-4, 1984. Abstracts of papers for presentation at the meeting are due November 25.

NWAW invites soil scientists, hydrogeologists, hydrologists, geologists, engineers, and others working with instruments designed to study groundwater systems to attend and share research results. Paper topics include groundwater sampling devices and quality measuring devices; valve zone measuring devices; devices for measuring water level; surface and borehole geophysical instruments; computer devices, data acquisition, and telemetry equipment; and contaminant detection and cleanup equipment.

Abstracts of 300 words or fewer should be sent along with a biographical sketch (no longer than 100 words) of each author, full mailing address, and phone number. For more information, contact David M. Nielsen, Conference Coordinator, NWAW, 500 W. Wilson Bridge Rd., Worthington, OH 43085 (telephone: 614-810-8355).

## Eurogeophysics

The European Geophysical Society (EGS) will hold the Eurogeophysics Assembly July 29-August 4, 1984, at Louvain-la-Neuve, Belgium, with open sessions on external geophysics and geophysical fluid dynamics.

Symposium and workshop topics will include future planetary missions; structure of pre-Alpine orogenies; long-lived eddies in oceans and atmospheres; models of oceanographic mesoscale phenomena; magnetospheric effects of seismic activity; first results of European geophysics and solar experiments on Spacelab; convection phenomena in geophysics; geophysical, petrological, and structural aspects of large-scale tectonic phenomena; paleomagnetism, age dating, and sedimentology of young sediments; motions and physical processes in atmospheres and hydrospheres as revealed by remote sensing techniques; and aspects of climate.

For information, contact EGS General Secretary, G. M. Brown, Dept. of Physics, University College of Wales, Aberystwyth, Wales, UK.

## Marine 3-D Data

December 15 is the deadline for submitting abstracts in the 4th Biennial Series of Exploration Geophysicists/U.S. Navy (SEG/USN) Joint Technical Symposium on Three-Dimensional Marine Data Collection, Processing, Interpretation, and Presentation. The symposium, sponsored by SEG and the Office of Naval Research, will be held March 13-15, 1984, at the National Space Technology Laboratories in Bay St. Louis, Miss. A workshop on "Understanding and Interpreting 3-D Seismic Data Volumes" will be held March 13. Use of 3-D information in both shallow and deep marine applications is the theme for the symposium, which will include such topics as navigational accuracies required for 3-D data, benefits of collecting and presenting information in 3-D, 3-D case histories, techniques, instrumentation, upper ocean variability in 3-D, and tomography.

Only 28-30 abstracts, each of approximately 300 words, can be accepted for presentation. Abstracts should be submitted, along with a biographical sketch and a statement of the types of projection facilities required, to J. A. Ballard, Chairman, SEG/USN Technical Program, NORDA, NSTL Station, MS 39829 (telephone: 601-688-4760).

## The AGU Chapman Conference on Natural Variations in Carbon Dioxide and the Carbon Cycle

Convenors: E. T. Sundquist and W. S. Broecker  
January 9-13, 1983  
Innsbruck  
Tarpon Springs, Florida

Natural Variations in Carbon Dioxide and the Carbon Cycle will bring together geologists who are studying various aspects of carbon cycle history; geochemical modelers; and biologists, oceanographers, and meteorologists who are familiar with present and potential future relationships among the carbon cycle, atmospheric CO<sub>2</sub>, and climate.

Questions to be discussed at this conference are: What caused the carbon cycle variations? How were they related to atmospheric CO<sub>2</sub>? Were they associated with climate changes consistent with the CO<sub>2</sub> climate predictive models? What are the long-term geochemical implications of fossil fuel CO<sub>2</sub>?

There will be sessions devoted to overview talks by experts on the application of ocean modeling, climate modeling, and the biosphere modeling to CO<sub>2</sub> as well as sessions emphasizing the geological record.

The meeting will be organized around six time slices: the last 2,000 years, the last 20,000 years, the last 2 million years, the Cenozoic, the Phanerozoic, and the Precambrian. Don't miss this exciting program!

Registration and housing information will be available by November 30. To be placed on a mailing list write: CO<sub>2</sub> Meeting, 2000 Florida Avenue, N.W., Washington, DC 20009 (202) 462-6903.

For program information contact: E. T. Sundquist, U.S. Geological Survey, 431 National Center, Reston, VA 22092 (703) 860-6083.

## AGU FALL MEETING

December 5-9, 1983  
San Francisco, California



Housing: Reservations will be accepted on a space availability basis only.

Send your housing form directly to the Housing Coordinator, AGU Fall Meeting, S.F. Housing Bureau, P.O. Box 5612, San Francisco, CA 94101.

## Preregistration Deadline: November 10

There is still time to preregister. Save time and money! Send your preregistration form to the AGU Fall Meeting, 2000 Florida Ave., N.W., Washington, DC 20009.

## Make your Airline Reservation: Call United

Dial the United toll free number 800-521-4041 (in Michigan, 800-482-0243). Give United your AGU Convention Number—4367—to ensure that you receive the AGU Discount Air Fare.

Registration and housing forms, the program summary, and airline information were published in *Eos*, October 18, 1983. For additional information, contact the AGU Meetings Department at 202-462-6903.

## Rio Grande Rift

The New Mexico Geological Society is soliciting papers for a field-conference guidebook on the "Rio Grande Rift-Northern New Mexico." The annual field conference, the society's 55th, will be based in Taos, N. Mex., October 10-13, 1984. The conference will feature field trips to the Rio Grande Rift area, and guidebook papers should be relevant to the study of that region. There will be no oral presentation of papers.

Titles and descriptions of prospective guidebook papers are due December 1. The papers should be of a summary nature of interest to a broad spectrum of earth scientists. Main topics will be the tectonics and magmatism of the Rio Grande Rift, which is a region of increasing international interest. Also among the topics are Precambrian geology, stratigraphy, sedimentology, paleontology, petrology, economic geology, geomorphology, hydrology, history, and archeology.

The paper's title, with a short description, should be sent to either of the two editors: W. Scott Baldrige, Los Alamos National Laboratory, Mail Stop 1078, P.O. Box 1683, Los Alamos, NM 87545, or Pat Wood Dicker, Gulf Oil International, P.O. Box 38506, Houston, TX 77236.

## Geophysical Year

## New Listings

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

**November 15-17, 1983** Symposium on Exclusive Economic Zone Mineral Development, Reston, Va. Sponsors: USGS, Mineral Management Service, and Bureau of Mines. Assistant Secretary, Energy and Minerals, Dept. of Interior, Washington, DC 20240; tel: 202-343-5891.

**March 13-15, 1984** Fourth Biennial SEG/USN Joint Technical Symposium on Three-Dimensional Marine Data Collection, Processing, Interpretation, and Presentation, National Space Technology Laboratories (NSTL), Bay St. Louis, Miss. J. A. Ballard, Chairman, NORDA, NSTL, MS 39829; tel: 601-688-4760.

**April 29-May 4, 1984** Petros Conference on Processes and Products of Multiscale Modeling and Measurement in the Marine, Gold Canyon Ranch, Ariz. Sponsors: Geological Society of America and USGS. J. E. Rieck, USGS, 345 Middlefield Rd., MS 75, Menlo Park, CA 94025.

## AGU

## Section Candidates

*Eos* is carrying biographies and photographs of all candidates for President-elect, General Secretary, and Foreign Secretary of the Union and for President-elect and Secretary of each Section. In addition, statements by the candidates for Union offices and for Section President-elect will appear. The sections and the date of the issue in which their material appeared are as follows:

**Geodesy: Geomagnetism and Paleomagnetism** August 30  
**Planetary and Planetary Science** September 27  
**Atmospheric Sciences** September 27  
**Tectonophysics** October 11  
**Seismology** October 18  
**Hydrology** October 25

The state of candidates for all offices was carried in the June 21 issue.

## Ocean Sciences: President-elect

Arnold L. Gordon, a member of AGU since 1962; 43 years old. Professor of Oceanography at Columbia University at the Lamont-Doherty Geological Observatory, Palisades, New York. Major research interest is physical oceanography, particularly in regard to climate relevance of ocean circulation and mixing. B.A., Hunter College, 1961; Ph.D., Columbia University, 1965, with employment at Lamont-Doherty Geological Observatory to the present. Membership in AAAS, AGU, AMS and Sigma Xi. 77 publications, 18 in AGU publications; many dealing with the Southern Ocean circulation and water mass formation. Editor of 8 volumes. Recipient of the U.S. Antarctic Service Medal. Participation in many review panels, national and international committees. Associate Editor of JGR, 1973-1976, and since 1981. Editor of *Eos*, overseeing The Oceanography Report since 1981.



Donald V. Hansen, a member of AGU since 1963; 52 years old. Holds degrees in Physics (B.S., 1954) and Oceanography (M.S., 1961; Ph.D., 1964), from the University of Washington, Seattle. Served on active duty in USAR as Meteorological Officer and Artillery Officer during 1964-1966. Subsequently worked as an engineer in testing and evaluation for Boeing Airplane Company.

## Statement

"Oceanographers' educational backgrounds are very diverse, representing the broad range of science. Yet there is the common interest in the ocean that ties us together into a 'community.' The Ocean Sciences section of AGU provides this group with its only national, and, through interaction with other groups, international professional organization. The Section, through its meetings, and by its *The Oceanography Report* appearing in *Eos*, allows frequent exchange of ideas, research plans and results, as well as discussion of various professional concerns we might have. I will encourage, and whenever possible, enhance this vital role by recognizing current and future problems and opportunities. By acting as a facilitator for exchange of ideas, I hope to enable the membership of the Section to meet these new developments and challenges from a position of knowledge and strength.

"While my term as *Eos* Editor for The Oceanography Report ends in 1984, I will continue efforts to make it the focal point for physical, chemical, geological, and biological oceanographers."

"As the study of the ocean becomes more complex and global, and continued progress is dependent on rather sophisticated and expensive facilities with more stress on research group concepts, there is an increasing need for an active professional society, such as our Ocean Sciences Section of AGU. The Section can aid not only in the organization of the required resources, but also ensure that our development is not lost to the impending 'big science.'"

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pany, and as a science teacher with Seattle Public Schools. Following graduate education held a position as Research Assistant Professor at the University of Washington before accepting a position as Research Oceanographer with the U.S. Department of Commerce. Has been director of the Physical Oceanography Laboratory, Atlantic Oceanographic and Meteorological Laboratory (AOML) since 1969, and additionally was Acting Director, AOML, during 1978-1980. A member also of Sigma Xi, ASLU, AAAS, Florida Academy of Science, and International Association of Geographers, and holds an appointment as Adjunct Professor at the University of Miami. Over 44 publications in oceanography, 3 of which appeared in AGU journals; numerous presentations and chairmanships of scientific sessions at the AGU meetings. Has published results of research on estuarine circulation, tides, the Gulf Stream system, and continental shelf circulation. Has also published on the Gulf of Alaska and Beaufort Sea, and presently is working on circulation in the tropical Pacific Ocean. Has received NOAA awards for distinguished scientific achievement in 1971, 1977, and 1980, and other NOAA awards. Served as Associate Editor, *Journal of Geophysical Research*, during 1966-1968, and has served on several special panels for AGU, NAS, and other organizations.

## Ocean Sciences: Secretary

Barbara M. Hickey, a member of AGU since 1974; 37 years old. Research Associate Professor, University of Washington. Major interests: coastal and equatorial circulation. B.S. in mathematics and physics, University of Toronto, 1967; M.S. (1969) and Ph.D. (1975) in oceanography, Scripps Institution of Oceanography, University of California, San Diego. Research Assistant Professor, 1974-1980, University of Washington. Research Associate Professor since 1980. 12 refereed publications, 4 published by AGU. Oceanography Chairman for 1982 AGU Fall Meeting.



## William C. Patzert

A member of AGU since 1973; 42 years old. Program Manager for Physical Oceanography at NASA Headquarters, detailed from Jet Propulsion Laboratory of California Institute of Technology. Major interests: satellite remote sensing of meso- and large-scale variability of ocean circulation aimed at improving understanding of climate research. B.S. in physics and mathematics, Purdue University, 1964; Ph.D. in physical oceanography, University of Hawaii, 1972. Oceanographer at Scripps Institution of Oceanography, 1972-82. Member: AGU, AMS, Sigma Xi, Sigma Pi, Sigma Gamma Epsilon, North Pacific Experiment (NOPAX), Executive Committee, Co-chairman, NOPAX Equatorial Panel, SCOR Working Group 66 (Oceanography), Applications of Drifting Buoys, Expedition leader and experiment coordinator for various NOPAX field experiments in the Pacific Ocean. Served on many committees, planning group, and U.S. delegations to develop cooperative international research projects relating to El Niño and tropical ocean dynamics. Editor, *El Niño Watch Atlas*, 24 publications, 10 technical reports, 2 published by AGU. Chaired several oceanography sessions at AGU meetings.



## Statement

"The principal function of each section of AGU is to strengthen the field by promoting communications among the membership, and between the membership and lay persons. It appears to me that as a result of the scientific journals sponsored by the Union, topical papers in the *Oceanography Report* in *Eos*, and the several special interest newsletters in more or less regular circulation, communication among the membership, and even the nonmembers associated with the national research institutions, is good. Furthermore, although like all other organizations we must continue vigilance with respect to maintaining membership, the present level of section affiliation by professionals associated with established research institutions also is gratifying.

"There are however at least two areas in which special efforts are merited. The first of these is action to ensure the participation of new professionals becoming associated with the latest growing segment of oceanography. The numerous large and small companies established to address environmental, developmental, and other aspects of applied oceanography. This cadre of commercial professionals is likely to become a major segment of our discipline in the future. It is vital that it be kept in communication with the more traditional part of the discipline.

"Another point of communications that can be improved is that between ocean scientists and the general public. We have most-

## Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Riad Al-Dabbagh (H), John M. Farr (H), Paul C. Fiedler (O.A.), Russell Flegel (O), Nelson G. S. Freeman (O), Phyllis S. Greifinger (SM), Terry D. Kelly (SA), Alfred Kracher (P), David London (V), Stanley A. Mertzman (V), Masao Minagawa (V), Asunmi Ohtsura (M), Robert A. Olson (S), Gerald T. O'Mara (H), William A. Robertson (GP), Guillermo Rodriguez (T), Derek Peter Smith (SA), Jack T. Stegman (SA).

## Student Status

Robin E. Bell (T), Greg N. Boismont (T), John A. Chifflet (S), Kathleen Ann Devaney (P), Louis H. Ealey (S), Sue A. Ferguson (M), Eric J. Fielding (T), Michael Folio (T), Ali Molanad Ghazi (V), Keith A. Goetz (SS), Francis P. Kelly (O), Bruce T. Marshall (H), Frederic Mathieu (S), Marcel Nelson (P), Peng Fang (G).

## Top Sponsors

One thousand eight hundred and two new members have been elected through September 30, 1983. The top sponsors, AGU members sponsoring three or more new members, are listed below:

Eight Members: Robert T. Hodgson, Christopher N. K. Moers, Erwin Siebel.  
Six Members: Harold H. Denarest, Jr., Carl Kisslinger, Karim Masson, H. J. Seton-Alon, Paul E. Myers.

## GAP

## Separates

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## Aeronomy

DAVID observation and monitoring of radiation measurements of STATIONER NO. 700 FROM THE SOLAR MESOSPHERE FLYER SATELLITE (SOFIS) Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado, 80509. M. J. R. Bosch, J. T. Koon, J. M. Zandvoort, and C. A. Barlow. The visible light spectrometer on board the Solar Mesosphere Explorer spacecraft monitors atmospheric and ionospheric parameters at altitudes from 100 to 1000 km. The instrument provides nearly complete coverage over an extended period of time. The instrument data analysis is described in detail and NO results for winter/spring 1982 are presented and compared to ground-based observations. Agreement with other measurements is good, and comparison with NO results indicates that although the overall coverage before and after the instrument is good, the data indicate that NO has a strong memory of the physical conditions present in the atmosphere. J. Geophys. Res., Atmos., Paper 20041.

## Exploration Geophysics

3D10 Computer applications: INTEGRATION OF SEISMIC REFRACTION DATA BY COMPUTER AND CONTINUOUS FRACTIONATION. A. J. M. Nieuwenhuis, Department of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California at San Diego, La Jolla, CA 92037.

An algorithm is presented for the accurate evaluation of travel time corrections for seismic refraction data. The algorithm is based on the use of a non-linear function of the travel time, defined here as the non-linear function of the travel time, that is widely applicable to the standard travel time correction. The algorithm performs the automatic correction of the travel time of the seismic refraction data and the integration of the travel time data. The algorithm is based on the use of a non-linear function of the travel time, defined here as the non-linear function of the travel time, that is widely applicable to the standard travel time correction. The algorithm performs the automatic correction of the travel time of the seismic refraction data and the integration of the travel time data. 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